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## (54) Threaded fastener.

(57) A threaded fastener having a groove (13) or projection in a head (2) for engagement of jointing equipment is disclosed. The groove (13) or projection is composed of a center portion (A) and a radial portion (B) extending radially, outward of circumference of the center portion (A). The radial portion (B) includes a straight portion (13a) for receiving torque constantly and a rounded corner (13b) to prevent stress concentration for providing substantial strength against press-molding and applied torque.

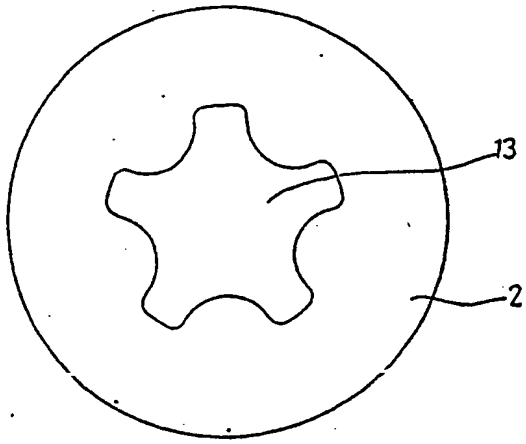


Fig. 4

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# THREADED FASTENER

## BACKGROUND OF THE INVENTION

### Field of The Invention

The present invention relates generally to a threaded fastener . Specifically, the present invention relates to a threaded fastener having a portion for bit engagement therein including five or six extended portions extending in radial directions from the center thereof.

### Description of The Background Art

Generally, threaded fasteners having a portion for bit engagement in which six portions extend in radial directions therein are well known in the art as threaded fasteners having excellent resistance against large amounts of jointing force or torque.

Conventionally, a threaded fastener is composed of a head and a threaded shaft. In the head, an engaging portion, comprised of a groove or projection, is formed. The center portion of the groove or projection is circular to allow for insertion of jointing equipment to provide a center portion. Six extended portions are equally spaced around periphery of the center portion for providing radial portions, holding a bit of the jointing equipment to receive torque derived from the equipment. A typical configuration of an engaging portion has six extended portions which extend in directions radially outward from the center of the engaging portion as shown in Japanese Utility Model Second Publication (allowed) No. 48-39959.

A plan view of the typical head having an engaging portion (projection or groove) such as the above cited disclosure is shown in **Fig. 1**. The threaded fastener is composed of a threaded shaft **1** and a head **2**. In the head **2**, a center portion **A** and radial portions **B** extending in radial directions are formed. The profile of a bit engaging portion **3** is determined as follows. Six dummy circles **4** are equally spaced along periphery of the circle **5** which defines the center portion **A**. Another six dummy circles **6** having smaller diameter than the circles **4** are spaced therebetween, respectively. The profile of the portion **3** is formed along a line via a tangent point of the circles **4** and **5**, a circumference of the circle **4**, and a circumference of the circle **6** which is remote from the center of the threaded fastener. This is repeated until a continuous contour forming the profile is completed. Plan view of another typical threaded fastener is also shown in **Fig. 2**. In this type of threaded fastener, profile of the portion **3** is determined along a line via a tangent point of the dummy circles **4** and **5**, a center facing portion of the circumferences of dummy circles **4**, and a circumference of a dummy circle **7** formed along a line through the centers of the circles **4**.

In the type of shown in **Fig. 1**, when torque is applied to the bit engaging portion **3** by radial engagement of the jointing equipment, the torque converts to force **W** which works on the surface of the radial portion in a perpendicular direction. The force **W** is shared in component forces **F** in a direction of a tangent line of circumference of the head and **R** in a direction of diameter thereof. As a result, the force **F** is applied on the threaded fastener as a rotating driving force. This rotating driving force **F** is indicated as following formula;

$F = W \cos\alpha$

wherein $\alpha$ is a driving angle defined by a tangent line $l_1$ of inner circumference of the radial portion **B** at a point of force applied and a radius line $l_2$ lined through that point. Therefore, corresponding to the reduction of the driving angle $\alpha$, torque from the jointing equipment converts to rotating driving force **F** without loss. However, in this type of threaded fastener, $\alpha$ when becomes about 25° or so, conversion loss of torque becomes relatively larger.

In the type of shown in **Fig. 2**, when a point of force applied is located most remote from the torque not-transferred portion, that is where the circumference of the circle **7** meets the circumference of the circle **4**, the driving angle a becomes zero, then conversion loss of torque also becomes zero. However, practically, because the engagement member of the jointing equipment is formed relatively smaller than the bit engaging portion, the point of force applied is slightly moved inward of a theoretical tangent point at which angle $\alpha$ becomes zero. Therefore, conversion efficiency of torque fluctuates slightly corresponding to fluctuation of the point of force applied. As a result, stable and high conversion efficiency can not be obtained according to these types of threaded fasteners. Additionally, because corners of the radial portion **B** are shaped having angles of 90°, corners portions tend to be fragile to stress concentration when the bit engaging portion is press-molded.

## SUMMARY OF THE INVENTION

It is therefore a principal object of the present invention to provide a threaded fastener having high conversion efficiency of torque.

It is another object of the present invention to provide a threaded fastener having stable conversion efficiency of torque.

It is further object of the present invention to provide a threaded fastener having sufficient strength to resist stress at edge portions of the groove, even when formed by press-molding.

In order to accomplish the aforementioned and other objects, a threaded fastener is composed of a threaded shaft and a head having a tightening torque receptacle which has a center portion and plurality of radial portions extending radially outward from a center portion, the radial portions being circumferrentially distanced at an angular interval less than 90°, each of radial portion has a torque receiving surface extending in parallel with radius line thereof.

## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiments of the invention. However, the drawings are not intended to imply limitation of the invention to a specific embodiment, but are for explanation and understanding only.

In the drawings:

**Fig. 1** is a plan view of a head according to the prior art;

**Fig. 2** is a plan view of another head according to the prior art;

**Fig. 3** is a cross sectional view of a threaded fastener according to the present invention;

**Fig. 4** is a plan view of a head according to the present invention;

**Fig. 5** is an enlarged plan view of a **Fig. 4**;

**Fig. 6** is a plan view of a variation of **Fig. 5**;

**Fig. 7** is a plan view of further variation of **Fig. 5**;

**Fig. 8** is a plan view of a head according to the second embodiment of the present invention;

**Fig. 9** is an enlarged partial view of **Fig. 8**; and

**Fig. 10** is a plan view of a head according to the third embodiment of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, particularly to **Figs. 3** and **4**, a threaded fastener is composed of a threaded shaft **1** having helical projection around circumference thereof (thread) and a head **2** which formed integrally with the top of the threaded shaft **1**. A bit engaging groove **13** is formed in the head **2** being concentrically with the threaded shaft **1**. **Fig. 5** is an enlarged plan view of **Fig. 4**. The bit engaging groove **13** is composed of a center portion **A** where torque derived by a jointing equipment is not transferred, and five radial portions **B** which are equally spaced around the periphery of the portion **A** being radially extending outward from the center of the threaded fastener. An extended portion of the radial portion **B** is formed having a straight line portion **13a** which extends parallel with a radius line $l_3$, and a corner **13b** of the portion **B** is formed to have rounded shape. The radial portions **B** are formed as follows. Five dummy circles **14** are equally spaced along the periphery of the circle **15** which defines the center portion **A**. Two dummy circles **16** having smaller diameter than the circle **14** are spaced therebetween being contact with the circles **14**, respectively. A first pentagonal dummy line **17** is formed through the center **o** of each adjacent dummy circle **14**, and a second pentagonal dummy line **18** is formed through the center **o'** of each adjacent dummy circle **16**. The profile of the groove **13** is formed along a line via a tangent point of the circles **14** and **15**, an inwardly facing portion of the circumference of the circle **14**, the straight line **13a** formed between tangent points of the first line **17** and the second line **18** respectively with the circles **14** and **16**, a circumference of the circle **16** which circumference is remote from the center of the threaded fastener, a circumference of a dummy circle **19** lined through the centers of the dummy circles **14**, a circumference of another dummy circle of **16** which circumference is remote from the center of the threaded fastener, and another straight line **13a** formed between tangent points of the second and the first lines respectively with the circles **16** and **14**. This is repeated sequentially, completing the profile of the groove **13**. Therefore, extended portions of the groove **13** are formed to have a straight line portion derived from two tangent points of the line formed through the centers of the circles **14** and **16** respectively thereon, and a rounded shape derived from the circumference of the circles **16**.

Curvature of the rounded shape of the groove **13** depends on variation of radius r of the dummy circle **16**. Concurrently, the length of the straight portion **13a** is also depends thereon. **Fig. 6** shows the case of $r = N/8$ (wherein N is width of the radial portion **B**), and **Fig. 7** shows the case of $r = G/2 \times (1-\cos\beta)$ (wherein G is diameter of a circle **19** which indicates peripheral circumference of the groove **13**, $\beta$ is a central angle defined by lines extending between the groove center and the center of N and the center of the circle **14**, respectively). When r becomes shorter than N/8, curvature of the rounded portion is not enough to establish the strength against press-molding. On the other hand, when r becomes longer or equals to $G/2 \times (1-\cos\beta)$, the straight portion **13a** can not be obtained. Therefore, the preferred range of radius r of the dummy circle **16** is determined within the range of

$N/8 \leq r < G/2 \times (1-\cos\beta)$.

The ratio of central angle $\theta$ defined by the circumference of the circle **14** against central angle $\theta_1$ defined by the circumference of the circle **16** depends on diameter **d** of the circle **14**. Sheared sections of the bit engaging groove **13** and the bit of the jointing equipment can be substantially equaled when $\theta:\theta_1 = 1.4:1$. This is preferred ratio because durability of the jointing equipment can be raised if the ratio is determined as this value. Central angles $\theta$ and $\beta$ at this ratio are indicated in the following formula;

$\theta = 360°/n \times 1.4/2.4$

$\beta = 360°/2n$

wherein n : number of the radial portions **B**.

Therefore, when number of the portions **B** is five, $\theta = 42°$ and $\beta = 36°$, when number of the portions **B** is six, $\theta = 35° \beta = 30°$, etc.

**Figs. 8** and **9** show a head according to the second embodiment of the present invention. A groove **23** having five extended portions extending in radial directions from the center thereof is formed in a converted tapered configuration. Profiles of bottom and top thereof are formed in the same manner of the previously mentioned first embodiment. However, top of the groove **23** is formed with a slightly larger diameter than that of bottom except the diameter of dummy circles **24'**. Diameter of the circles **24'** are formed to have same diameter **24** as those on the bottom of the groove. Thus, an inner circumference of the groove **23** is shaped as an outwardly tapered surface **T**. This derives straight line **23a'** longer than that of **23a** which is formed on the bottom of the groove **23**. Thus, all straight portions of the surface **T** of the groove taper widely.

It is also possible that the groove **23** be formed with a projection for bit engagement having the same profile (five radially extended portions). However, in this case, the projection is formed with a tapered configuration with the bottom thereof being wider.

Same jointing equipment can be used without concern for threaded fastener sizes if the groove top and the projection bottom are formed to have same diameter.

**Fig. 10** shows a head having six extended portions in a groove according to the third embodiment of the present invention. The groove is formed in the same manner of the previously mentioned embodiment, and it can be also be formed with a converted tapered configuration or alternatively, tapered projection as aforementioned.

When manufacturing the threaded fastener of th present invention, a punching machine of the same profile as a desired groove is used for press-molding of the head. The head is broken by shearing force derived from the punching machine corresponding to pressure applied. Thus, a bit engaging groove can be obtained substantially along the profile of the punching machine. According to the present invention, because corners of the radial portions of the groove are formed in rounded shape, stress concentration cannot be caused at those portions, therefore, fragility of the corners does not occur.

Corresponding to rotation of the jointing equipment, torque from the jointing equipment is applied to an inner surface of the radial portions in the groove, and the threaded fastener is threaded into a threaded fastener hole. When torque is converted to rotating driving force, the force application point on the portion may fluctuate due to slight relaxing of the engagement between the jointing equipment and the groove. However, according to the present invention, a straight line is formed adjacent the force application point, thus fluctuation points are on the straight line of the surface of the portion. Therefore, driving angle $\alpha$ is kept substantially constant always and is kept to a relatively small value, i.e., $\alpha = 15°$. Accordingly, stable and high conversion efficiency of torque can be obtained.

Additionally, if the engaging portion of the head is formed of a converted tapered groove or tapered projection, insertion of the jointing equipment can be accomplished more easily.

While the present invention has been disclosed in terms of the preferred embodiment in order to facilitate better understanding of the invention, it should be appreciated that the invention can be embodied in various ways without depending from the principle of the invention. For example, a head having same diameter of that of a threaded shaft and helical projections (thread) on a circumference thereof can be available. Therefore, the invention should be understood to include all possible embodiments and modification to the shown embodiments which can be embodied without departing from the principle of the inventions as set forth in the appended claims.

## Claims

1. A threaded fastener comprising;
a threaded shaft,
a head having a tightening torque receptacle which has a center portion and a plurality of radial portions extending radially outward from said center portion,
said radial portions being circumferentially distanced at an angular interval less than 90°, and each of radial portion having a torque receiving surface extending in parallel with radius line thereof.

2. A threaded fastener as set forth in claim 1, wherein said radial portion further comprising substantially rounde radially outer end to prevent con-

centration of stress thereon.

3. A threaded fastener as set forth in claim 1, wherein the number of said radial portions is five.

4. A threaded fastener as set forth in claim 1, wherein the number of said radial portions is six.

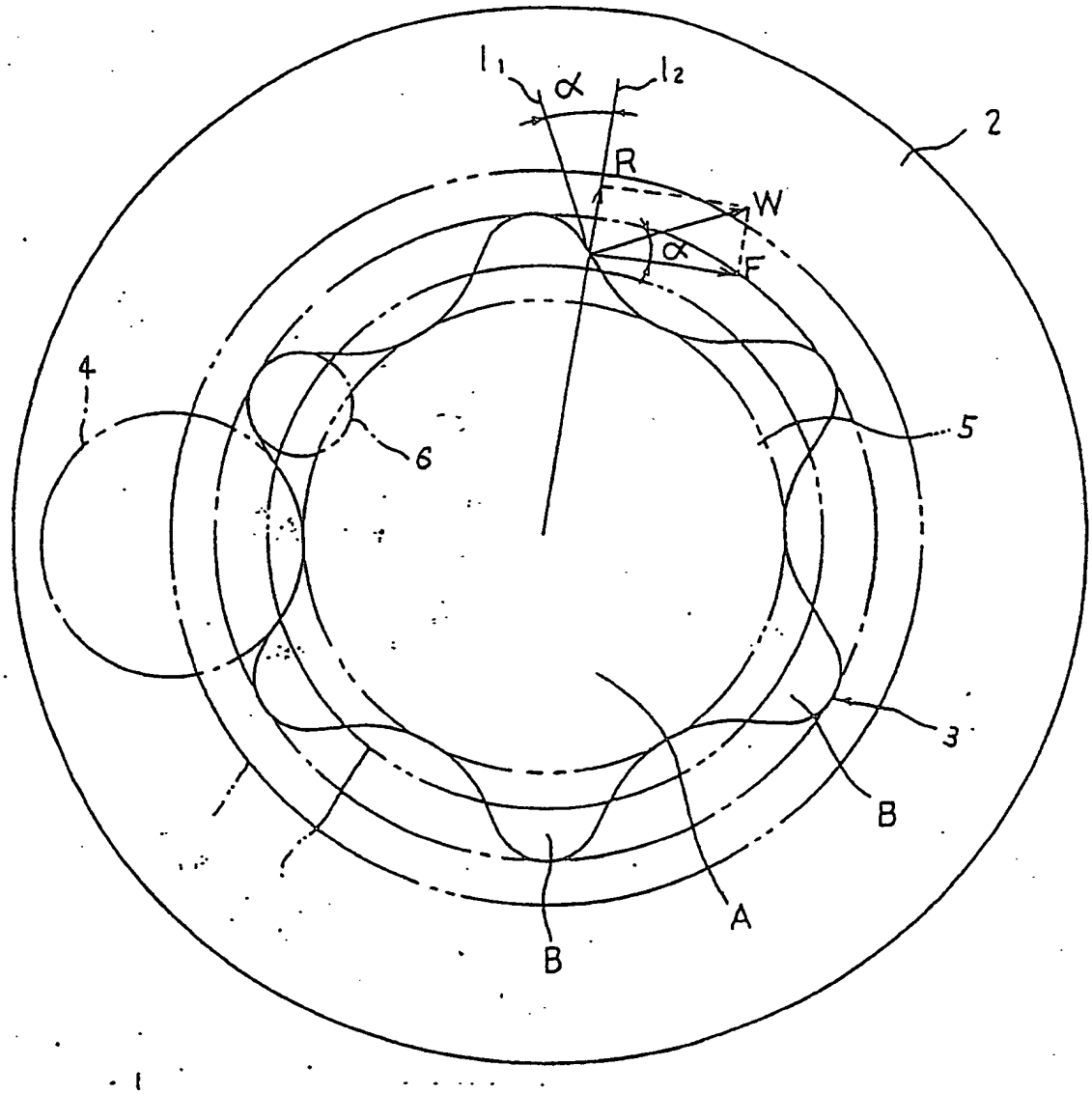
5. A threaded fastener as set forth in claim 1, wherein said receptacle forms a groove in said head.

6. A threaded fastener as set forth in claim 5, wherein said groove has a configuration tapering from top to bottom thereof.

7. A threaded fastener as set forth in claim 1, wherein said receptacle forms a projection on said head.

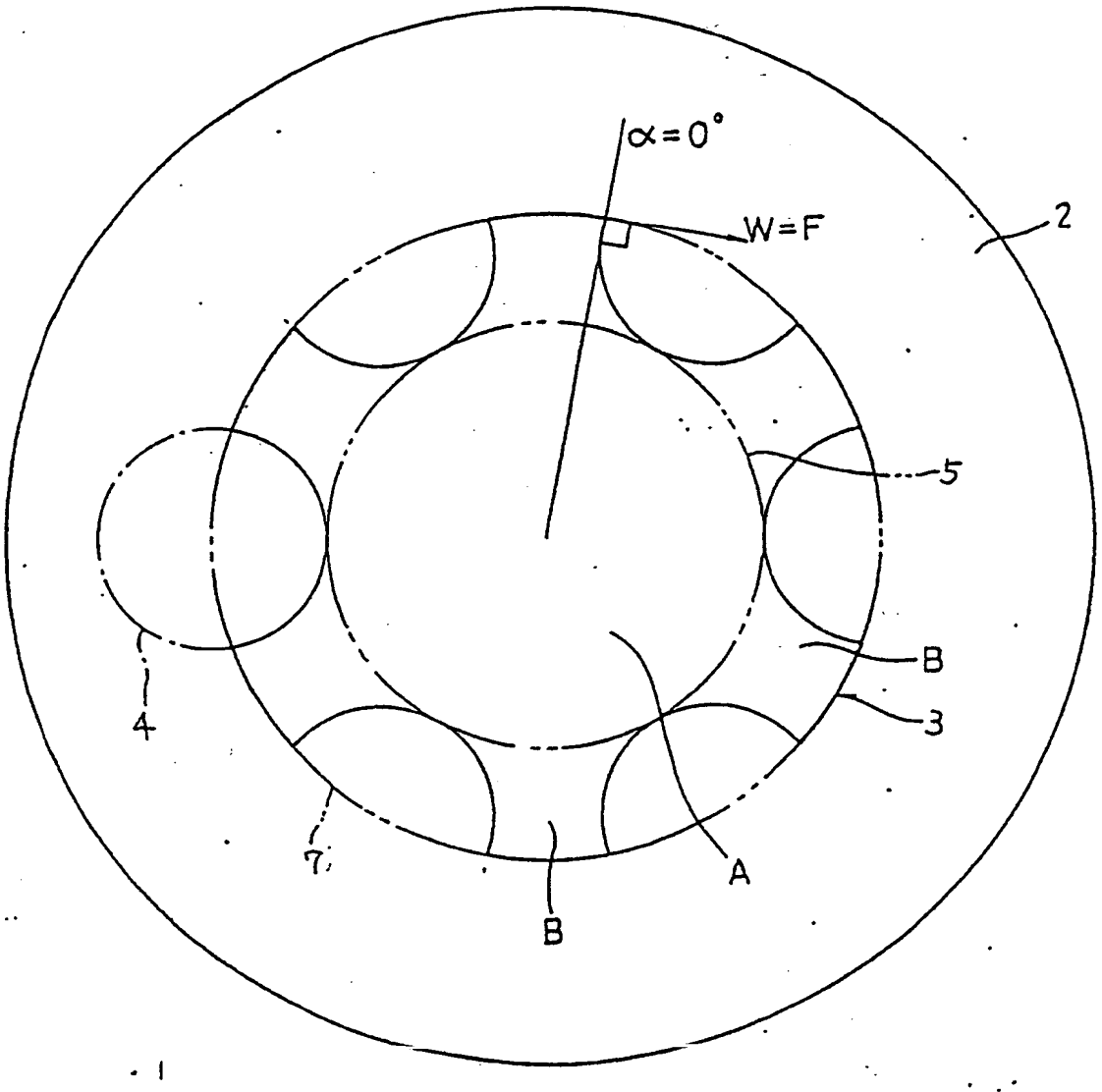
8. A threaded fastener as set forth in claim 7, wherein said projection has a configuration tapering from bottom to top thereof.

9. A threaded fastener as set forth in claim 1, wherein curvature of said rounded corners is determined at least N/8 concurrently with less than $G/2 \times (1-\cos \beta)$; wherein N is a width of said radial portion, G is a diameter of said receptacle, $\beta$ is a central angle defined by radius lines through the center of said radial portion and through the center of a distance of said radial portions.




PRIOR ART

Fig 1.




PRIOR ART

Fig. 2

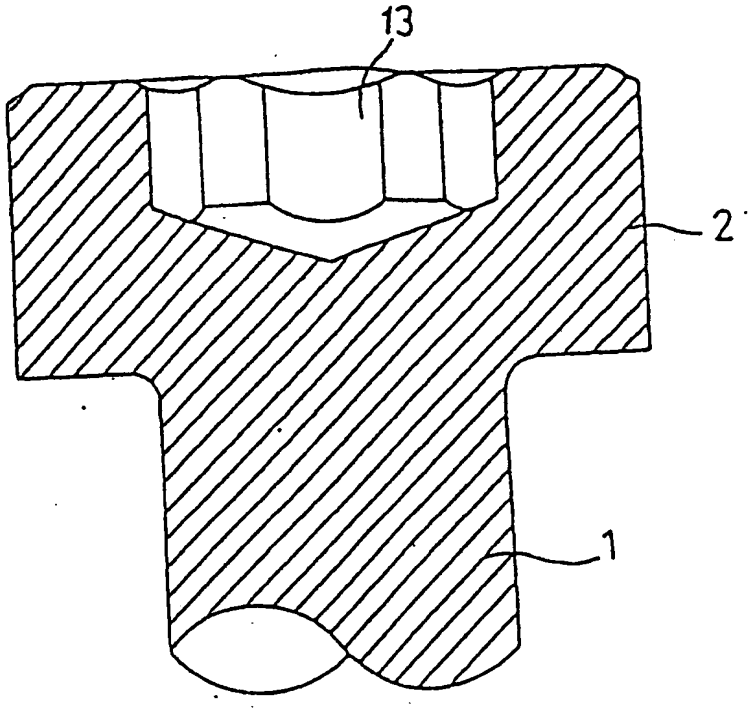



Fig. 3

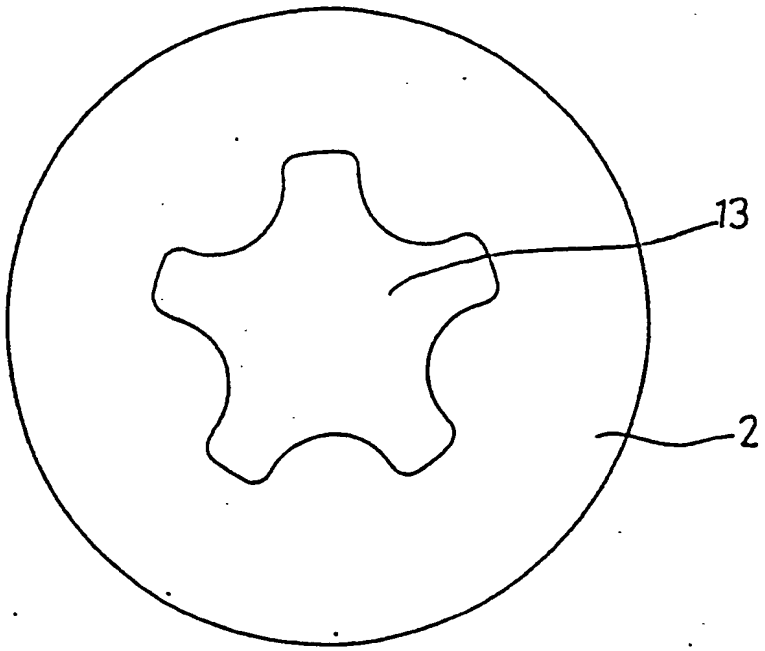



Fig. 4

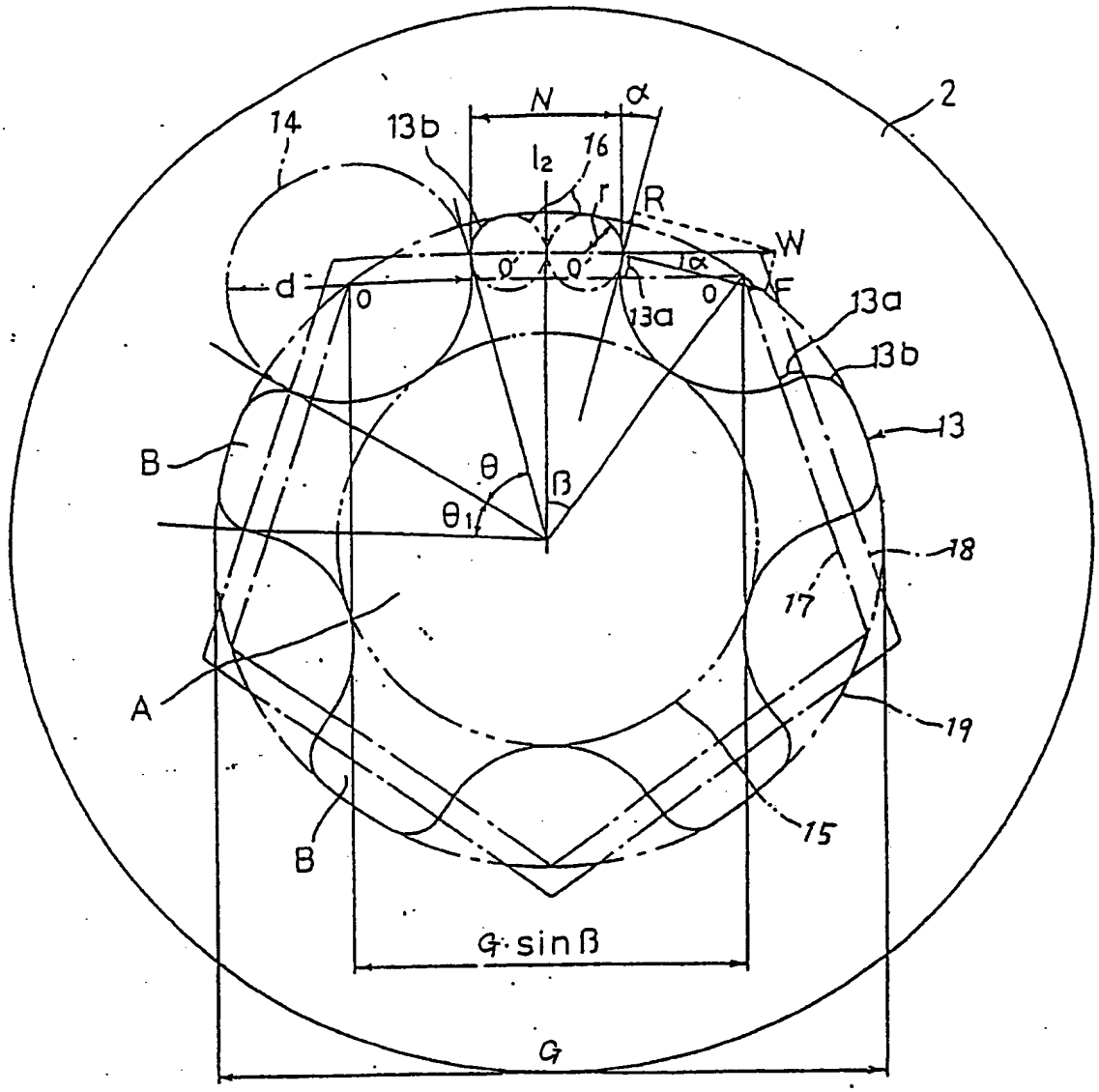

N
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Fig. 5

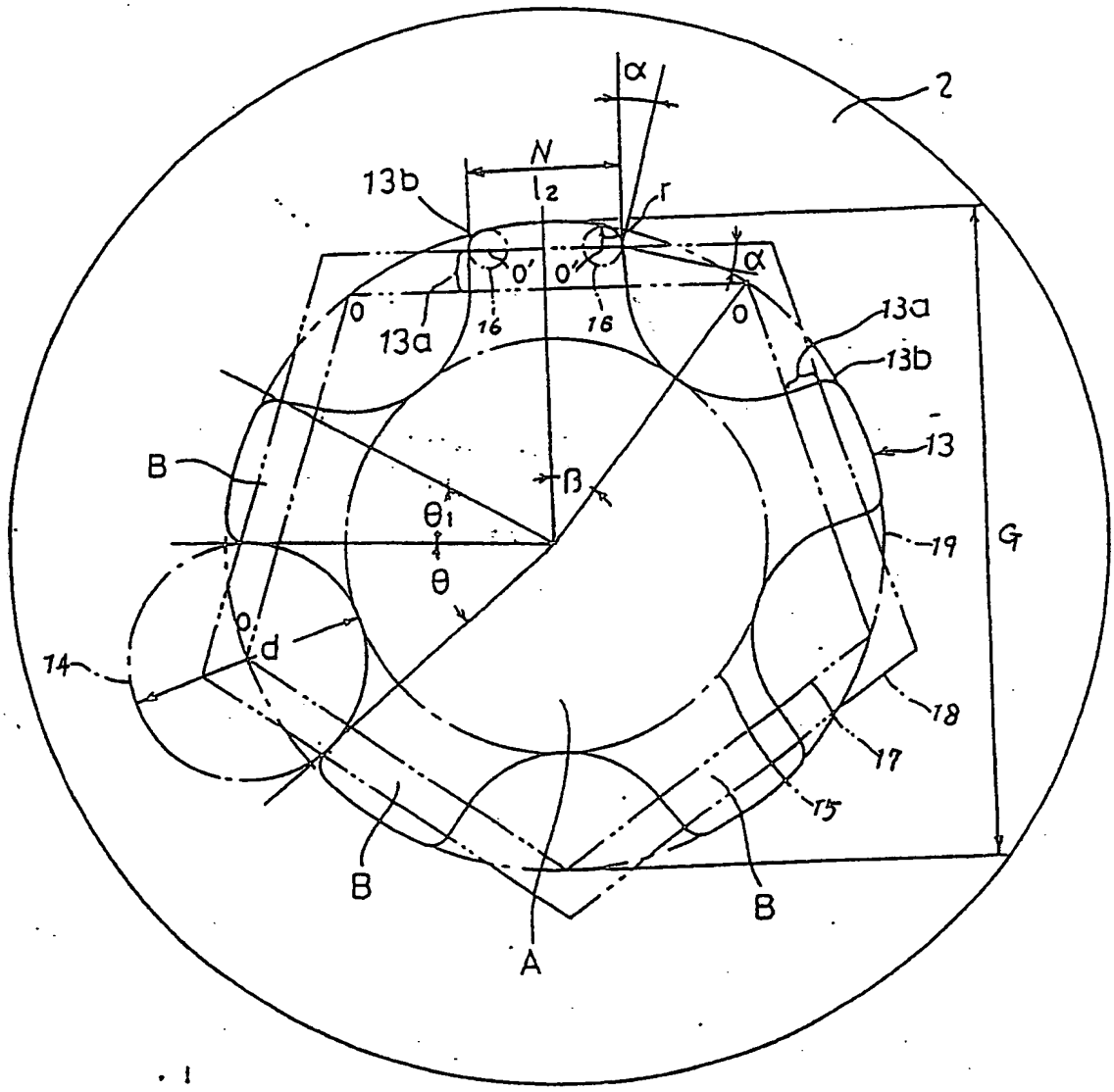


Fig. 6

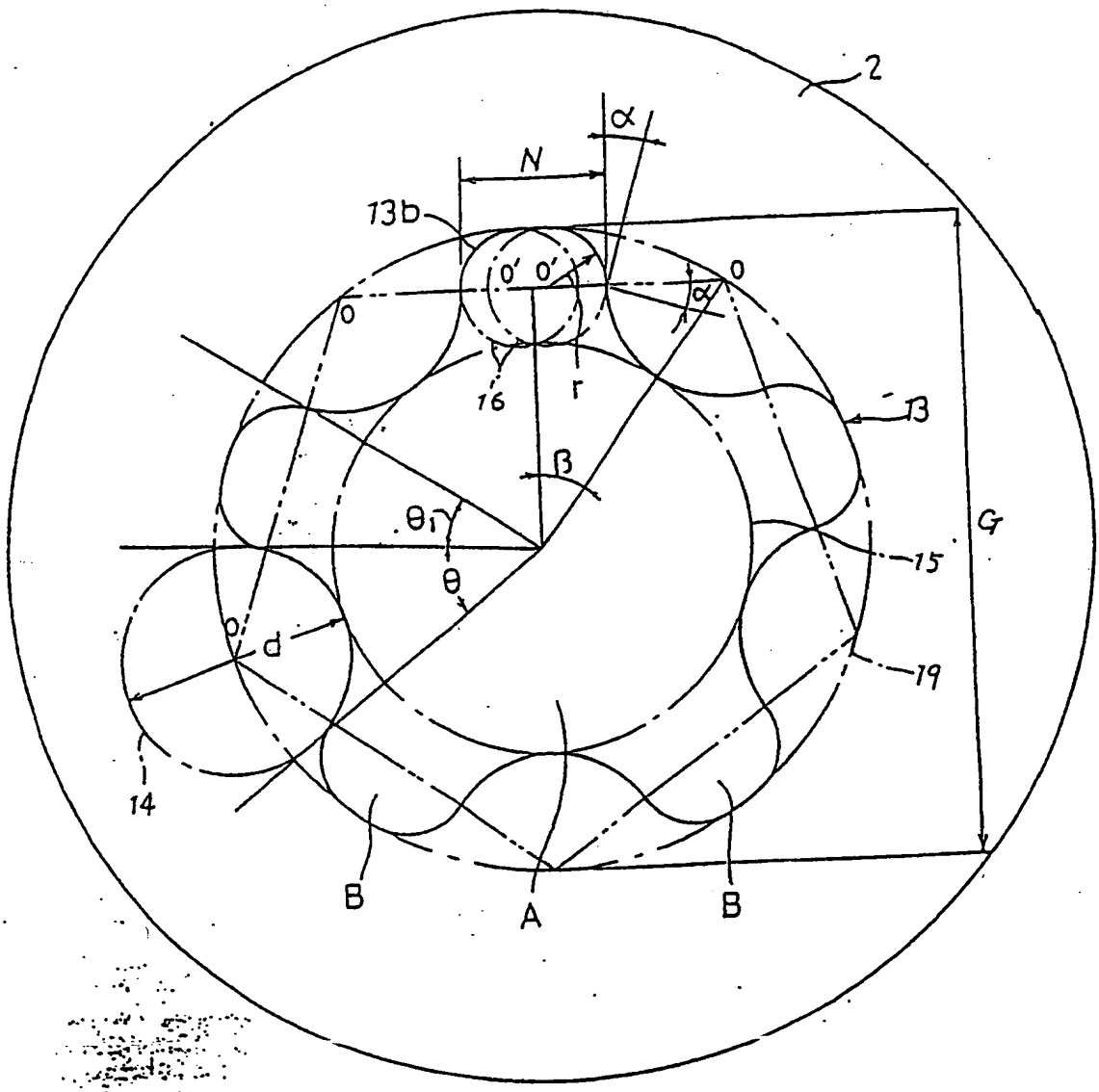


Fig. 7

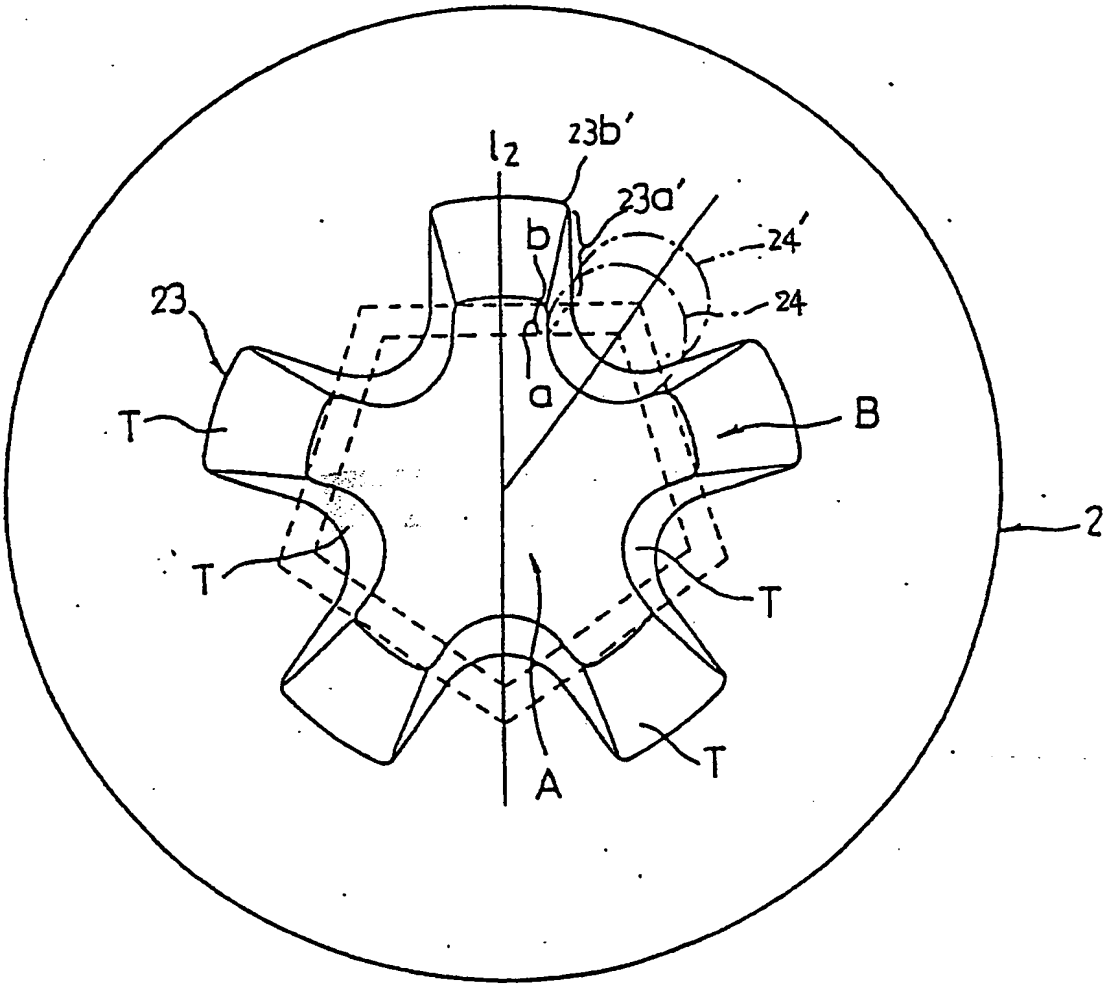


Fig. 8

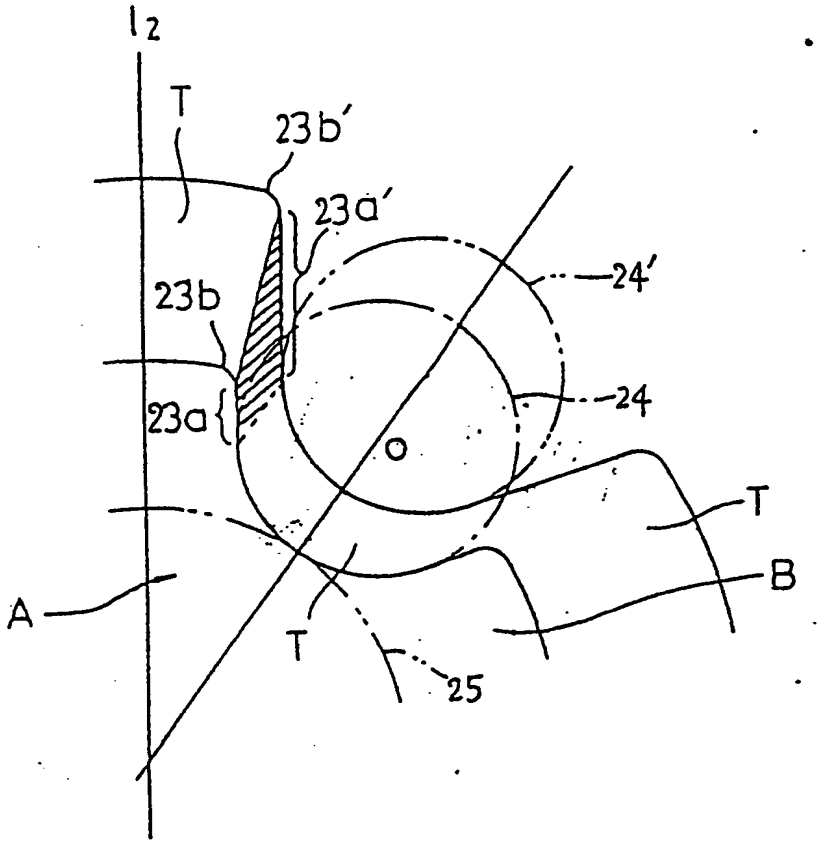


Fig.9

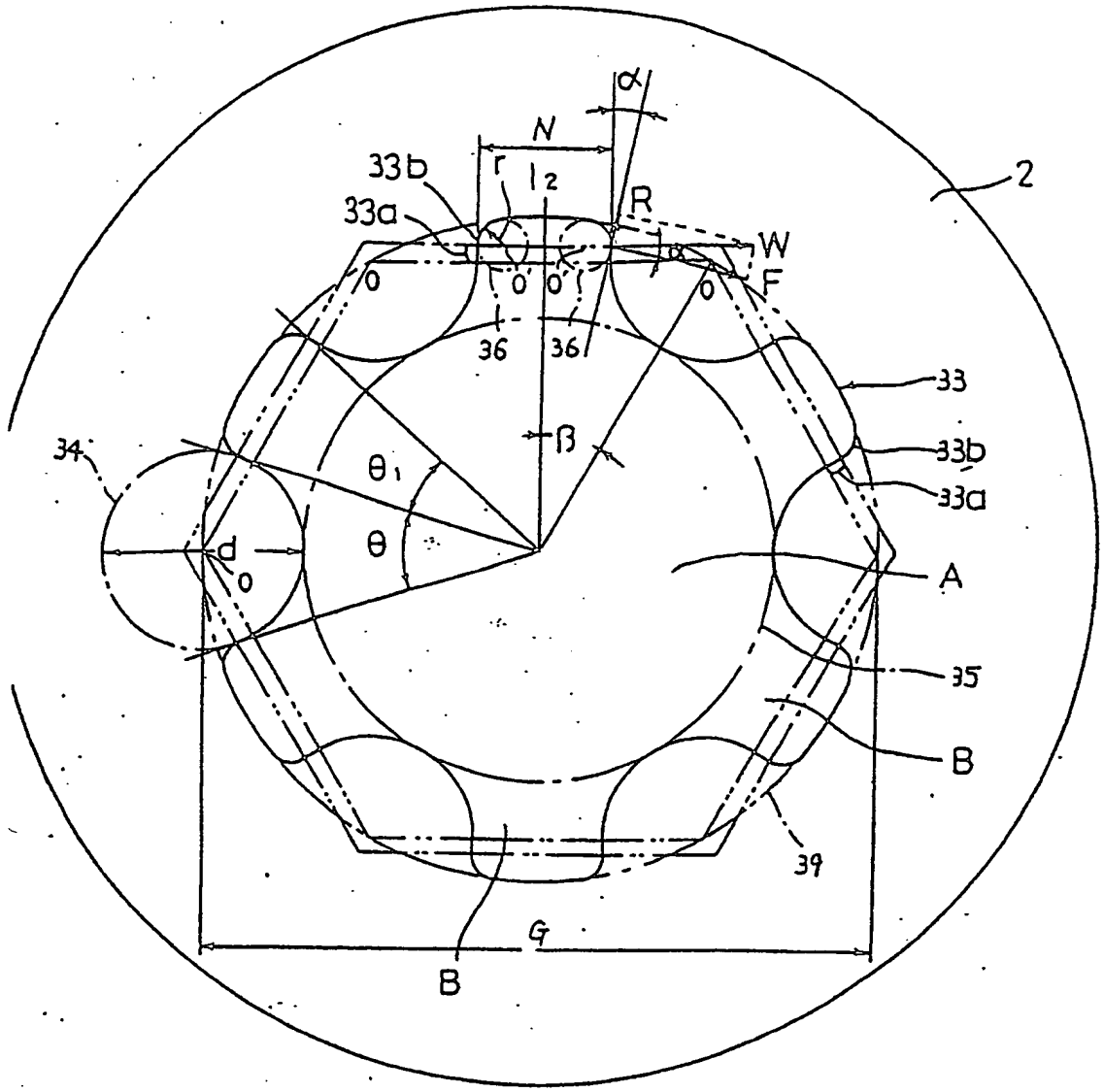


Fig. 10

Patent Office

# EUROPEAN SEARCH REPORT

Application Number

EP 90 31 2666

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| X | FR-A-2 558 220 (BULLONERIA BARGE)<br>* claim 1; page 7, lines 10-24; figures 1-3 * | 1,2,4-8 | F 16<br>B 23/00 |
| A | | 3,9 | |
| A | US-A-4 361 412 (STOLARCZYK)<br>* claim 1; figure 11 * | 1,2,4,7,9 | |
| A | DE-A-2 451 373 (YAMAMOTO BYORA)<br>* claim 1; page 12, lines 13-17; figures 2,5,8 * | 1,4-6,9 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F 16 B

The present search report has been drawn up for all claims

| Place of search | Date of completion of search | Examiner |
|---|---|---|
| Berlin | 28 February 91 | WESTERMAYER W G |

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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L: document cited for other reasons

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